A Tribute To GUGLIELMO MARCONI By Carlo Rubbia

What strikes us most forcibly about Marconi's style and the way in which he carried out his work is his modernity. Nowadays we talk more and more about internationalism: our national frontiers coincide with those of Europe and our stage is the world. We are concerned about the purpose and aims of science which must not just produce knowledge but also contribute to improving our quality of life and have useful repercussions for the community. One hundred years ago the young Marconi was also a pioneer in this sense: his ability to be at the same time scientist, inventor and entrepreneur enabled him to operate without frontiers in an international dimension. This is a characteristic which profoundly differentiates Marconi's work from that of the other great scientists of the time.

Marconi, was only in his early twenties when he brought his first experiments to a successful conclusion. Over twenty years had gone by since the great scientific revolution of electromagnetism, from Faraday to Hertz, together with Maxwell's wonderful synthesis of the phenomenology of electromagnetic waves (1873). In that extraordinary victory of human knowledge, the unification of the electric and magnetic fields in electromagnetism, Italy was conspicuous by her absence. It was not until the end of the 1920s, with Enrico Fermi, that the first real school of theoretical physics at world level was established in our country.

How can we explain this paradox? That is, that the fundamental, very important step of applying this knowledge completely escaped the scientific community of the time and that a young man in his early twenties with just a technical diploma, quite

obviously on the periphery of the scientific activity of the day, was the first to realize the incredible opportunities offered by the so-called herzian waves for communicating at a distance without wires. In my opinion this was due to an excessive "rationalization of concepts" on the part of the great majority of the scientific community of the time. Electromagnetic waves were then considered essentially like a form of "light". We only have to think of Hertz's classic experiments demonstrating diffraction, refraction, polarization, etc. From hertzian waves to X-rays, all waves were part of the same phenomenon: "unified" electromagnetic waves. Thus, once this mental framework had been accepted, hertzian waves would not have been able to increase the opportunities for using light to any great degree. After all, light does not climb mountains or cross oceans! Hertz died in 1894, one year before Marconi's discovery while Maxwell had died in 1879. Neither of them was there to see the birth of one of the most important practical consequences of their research: the Radio. For all that, Marconi did not live in a cultural vacuum. He studied electromagnetic waves with Righi, who was then a Professor at Bologna; he made an extremely intelligent use of the technological developments of Calzecchi-Onesti, a fellow-countryman living in Lombardy, the inventor of the "coherer".

The scientific and entrepreneurial community in Italy was not culturally ready to support his invention or understand its importance. The Italian government turned down the exclusive rights to his patent and it was only in England that he found the means and the will to develop his discovery. Can we really say that things have changed in the last hundred years? Subsequently, Marconi was also covered with honours in Italy where he was made a life senator. However, jobs were created elsewhere, for example in Great Britain, where the Marconi Company still exists.

Marconi's great superiority and originality lay in his giving priority to the "empirical" side of scientific research, outside and beyond rational conjecture: precisely what we mean by "natural philosophy" or, alternatively, by the "Galilean spirit. Obviously at that time nobody could rationally foresee the existence in the stratosphere, thanks to solar radiation, of a plasma reflector of

medium-long electromagnetic waves which channels their propagation around the earth. They did not understand the properties of the long electromagnetic waves which are refracted in the troposphere and therefore follow the terrestrial curvature. Most scientific interest, polarized by Hertz's experiments, was limited to the metric waves which correctly conform to the behaviour of light.

Fortunately, the sun does not emit an appreciable flow of radio waves, otherwise, as in the case of light, all our transmitters would be blinded by it. Just think, for example, that if we look at the sun through a radio-telescope it looks black, a shadow on the luminous radio radiation emitted by our galaxy, the Milky Way.

So we can say that Marconi was a man who had great intuition but who also had good luck: BUT WITHOUT A LITTLE BIT OF LUCK NO GREAT SCIENTIFIC DISCOVERIES WOULD EXIST. Fleming, for example, was a lucky man: how could he have foreseen that while he was studying the behaviour of molds he would discover penicillin.

Marconi's first invention was the antenna-earth structure which is still well-known today. Many years of study and research, in which Marconi was certainly the pioneer, made it possible to transform the Radio into what it is today. Mention must also be made of the introduction of tuning which made it possible for several stations to transmit simultaneously on different frequencies and the introduction of the triode amplifier, discovered by the American, de Forest in 1907. In my opinion, the amplification of signals was the key to success. Today, for example, less than a century later, man has practically reached the theoretical limit of sensitivity, that is, the maximum that is theoretically possible, limited by the noise due to the thermal vibration of the electrodes in the antenna. Just think for example of the pictures transmitted by Voyager from hundreds of millions of kilometres away (the signal took hours to reach the earth) with a transmission power of little more than a torch battery (a few watts). This shows once more the profound, fundamental technological difference between electromagnetic waves and light. In other

words, it is as if one could see the light of a little pocket torch shining from the limits of our solar system!

Another example is the picture of the "infant" universe, that is, when it was only 100,000 years old, preserved by radio radiation which, after having travelled for 15 billion years through empty space, is picked up and reconstructed by the COBE satellite.

The Radio and the applications that are associated with it (television, etc.) have helped to unite our planet and we have learnt to know each other better: There is no doubt that this is an important contribution towards making our world a better one.

I should like to conclude with a hope and a wish. If one day we discover that there is life and INTELLIGENT BEINGS in space, it will certainly be because another extraterrestrial Marconi has discovered the Radio out there too. In fact, it has been scientifically proved that communication between galactic civilizations, hundreds of thousands of light years apart, is possible and I WOULD SAY ONLY POSSIBLE with Radio. Today scientists scan the skies with radio telescopes searching for intelligent signals, emitted both consciously and unconsciously by another faraway civilization. (Remember the beautiful and poetic scene in Spielberg's film: "ET-call Home").

The discovery, thanks to the Radio, that we are not the only Intelligent Beings in the Cosmos would be the supreme example and rightful crowning of the extraordinary potential of the invention and intelligence of our Guglielmo Marconi.